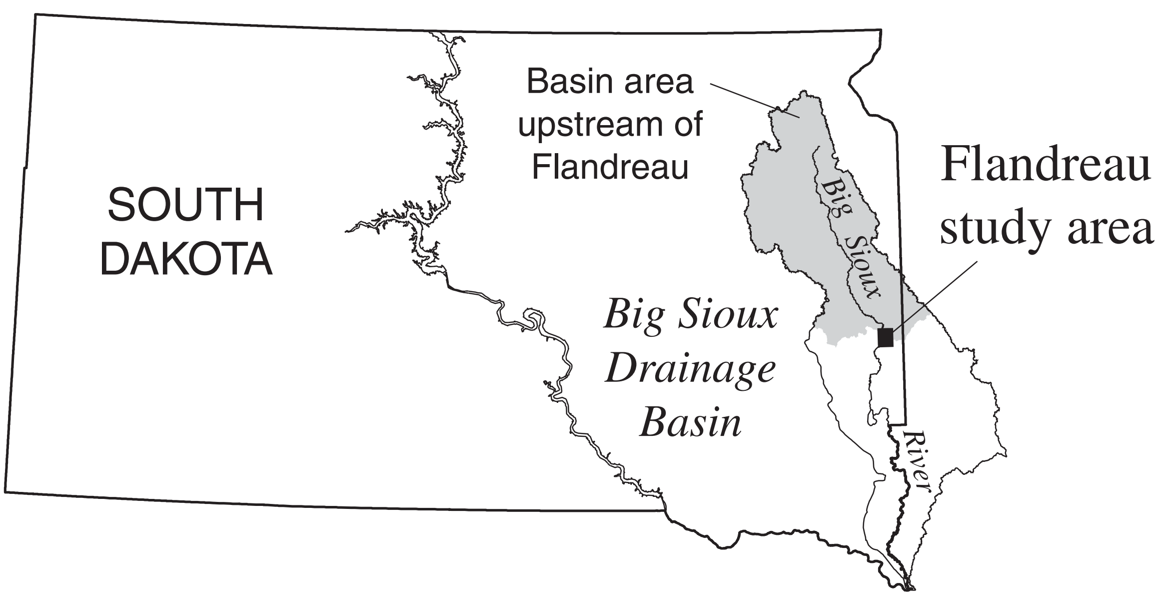
Prepared in cooperation with the
Flandreau Santee Sioux Tribe

Reconnaissance-Level Assessment of Water Quality near Flandreau, South Dakota

Open-File Report 02-474



U.S. Department of the Interior
U.S. Geological Survey

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2002	**N/A**	**-**

4. TITLE AND SUBTITLE
Reconnaissance-Level Assessment of Water Quality Near Flandreau, South Dakota

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Department of the Interior 1849 C Street, NW Washington, DC 20240

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR’S ACRONYM(S)

11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**37**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

U.S. Department of the Interior
U.S. Geological Survey

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By Bryan D. Schaap

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U.S. Department of the Interior

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
cubic foot per second	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
inch	2.54	centimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Temperature may be converted to degrees Fahrenheit (°F) or degrees Celsius (°C) by the following equations:

$$°F = (1.8 \times °C) + 32$$

$$°C = (°F - 32) / 1.8$$

Altitude: In this report, vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentrations: Chemical concentrations of substances in water are given in metric units of milligrams per liter (mg/L) and micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as mass (milligrams) of solute per unit volume (liter) of water. Micrograms per liter is a unit expressing the concentration of chemical constituents in solution as mass (micrograms) of solute per unit volume (liter) of water. Micrograms per liter are equivalent to milligrams per liter divided by 1,000.

Water year: Water year is the 12-month period, October 1 through September 30, and is designated by the calendar year in which it ends. Thus, the water year ending September 30, 2002 is called the "2002 water year."

Reconnaissance-Level Assessment of Water Quality near Flandreau, South Dakota

By Bryan D. Schaap

ABSTRACT

This report presents water-quality data that have been compiled and collected for a reconnaissance-level assessment of water quality near Flandreau, South Dakota. The investigation was initiated as a cooperative effort between the U.S. Geological Survey and the Flandreau Santee Sioux Tribe.

Members of the Flandreau Santee Sioux Tribe have expressed concern that Tribal members residing in the city of Flandreau experience more health problems than the general population in the surrounding area. Prior to December 2000, water for the city of Flandreau was supplied by wells completed in the Big Sioux aquifer within the city of Flandreau. After December 2000, water for the city of Flandreau was supplied by the Big Sioux Community Water System from wells completed in the Big Sioux aquifer along the Big Sioux River near Egan, about 8 river miles downstream of Flandreau. There is some concern that the public and private water supplies provided by wells completed in the Big Sioux aquifer near the Big Sioux River may contain chemicals that contribute to the health problems.

Data compiled from other investigations provide information about the water quality of the Big Sioux River and the Big Sioux aquifer in the Flandreau area from 1978 through 2001. The median, minimum, and maximum values are presented for fecal bacteria, nitrate, arsenic, and atrazine. Nitrate concentrations of water from Flandreau public-supply wells occasionally exceeded the Maximum Contaminant Level of 10 milligrams per liter for public drinking water.

For this study, untreated-water samples were collected from the Big Sioux River in Flandreau and from five wells completed in the Big Sioux aquifer in and near Flandreau. Treated-water samples from the Big Sioux Community Water System were collected at a site about midway between the treatment facility near Egan and the city of Flandreau. The first round of sampling occurred during July 9-12, 2001, and the second round of sampling occurred during August 20-27, 2001. Samples were analyzed for a broad range of compounds, including major ions, nutrients, trace elements, pesticides, antibiotics, and organic wastewater compounds, some of which might cause adverse health effects after long-term exposure. Samples collected on August 27, 2001, from

the Big Sioux River also were analyzed for human pharmaceutical compounds.

The quality of the water in the Big Sioux River and the Big Sioux aquifer in the Flandreau area cannot be thoroughly characterized with the limited number of samples collected within a 2-month period, and for many analytes, neither drinking-water standards nor associations with adverse health effects have been established. Concentrations of some selected analytes were less than U.S. Environmental Protection Agency drinking-water standards at the time of the sampling, and concentrations of most organic compounds were less than the respective method reporting levels for most of the samples.

INTRODUCTION

Members of the Flandreau Santee Sioux Tribe have expressed concern that Tribal members residing in the city of Flandreau experience more health problems than the general population in the surrounding area. There is a high incidence of endocrine disorders, including diabetes and thyroid gland problems, among Tribal members (Indian Health Service, Aberdeen, S. Dak., written commun., 1997). The members of the Tribe are concerned that the water supplies may contain chemicals that contribute to the health problems. Public and private water supplies are provided by wells completed in the Big Sioux aquifer near the Big Sioux River. Prior to December 2000, the city of Flandreau's water supply was obtained from wells completed in the Big Sioux aquifer within the Flandreau city limits. After December 2000, water for the city of Flandreau was provided by the Big Sioux Community Water System from wells completed in the Big Sioux aquifer near Egan, about 4 miles southeast of Flandreau (fig. 1).

Drinking-water contaminants that cause adverse health effects can be either natural or anthropogenic in origin. Arsenic occurs naturally in fairly large concentrations in ground water in eastern South Dakota. Anthropogenic compounds derived from wastewater discharges and agricultural operations also can contribute contaminants to drinking-water supplies. Within the Big Sioux River drainage basin upstream from Flandreau, there is considerable agricultural activity and there is potential for fertilizers, pesticides, and feed supplements to be introduced into both surface and ground water.

A review of historical water-quality data found that limited information was available from other investigations that were not intended to provide comprehensive assessments of the water quality in the Big Sioux aquifer and the Big Sioux River near Flandreau. The presence of compounds, such as nitrate and pesticides, with potential adverse health effects had been reported, but the spatial distribution of these compounds was not well known, and the limited number of analytes meant that other compounds might have been present but were not analyzed for.

A study to provide a reconnaissance-level assessment of water quality in the Flandreau area was initiated in 2001 by the U.S. Geological Survey (USGS) in cooperation with the Flandreau Santee Sioux Tribe. For this study, water-quality samples were collected from selected surface-water sites, ground-water sites, and a treated-water site (fig. 1) associated with Tribal water supplies. The first round of sampling occurred during July 9-12, 2001, and the second round of sampling occurred during August 20-27, 2001. Samples were analyzed for a broad range of physical properties and chemical constituents, including major ions, nutrients, trace elements, pesticides, antibiotics, and organic wastewater compounds. Samples collected on August 27, 2001, also were analyzed for human pharmaceutical compounds.

Because the city of Flandreau stopped operating its own water-supply system before the start of this study, it was not possible to collect treated-water samples from that system. However, untreated-water samples were collected from the Big Sioux River and the Big Sioux aquifer. The wells for the now inactive Flandreau water-supply system withdrew water from the Big Sioux aquifer, as do the wells for the active Big Sioux Community Water System, which currently supplies water to Flandreau. Samples of treated water were collected from the Big Sioux Community Water System to provide information on the quality of drinking water currently being supplied to Flandreau.

Very little is known concerning the occurrence and health effects of many unregulated synthetic organic compounds in aquatic environments. This study provides information concerning the occurrence of selected organic compounds within an intensive agricultural drainage basin located in the midwestern United States.

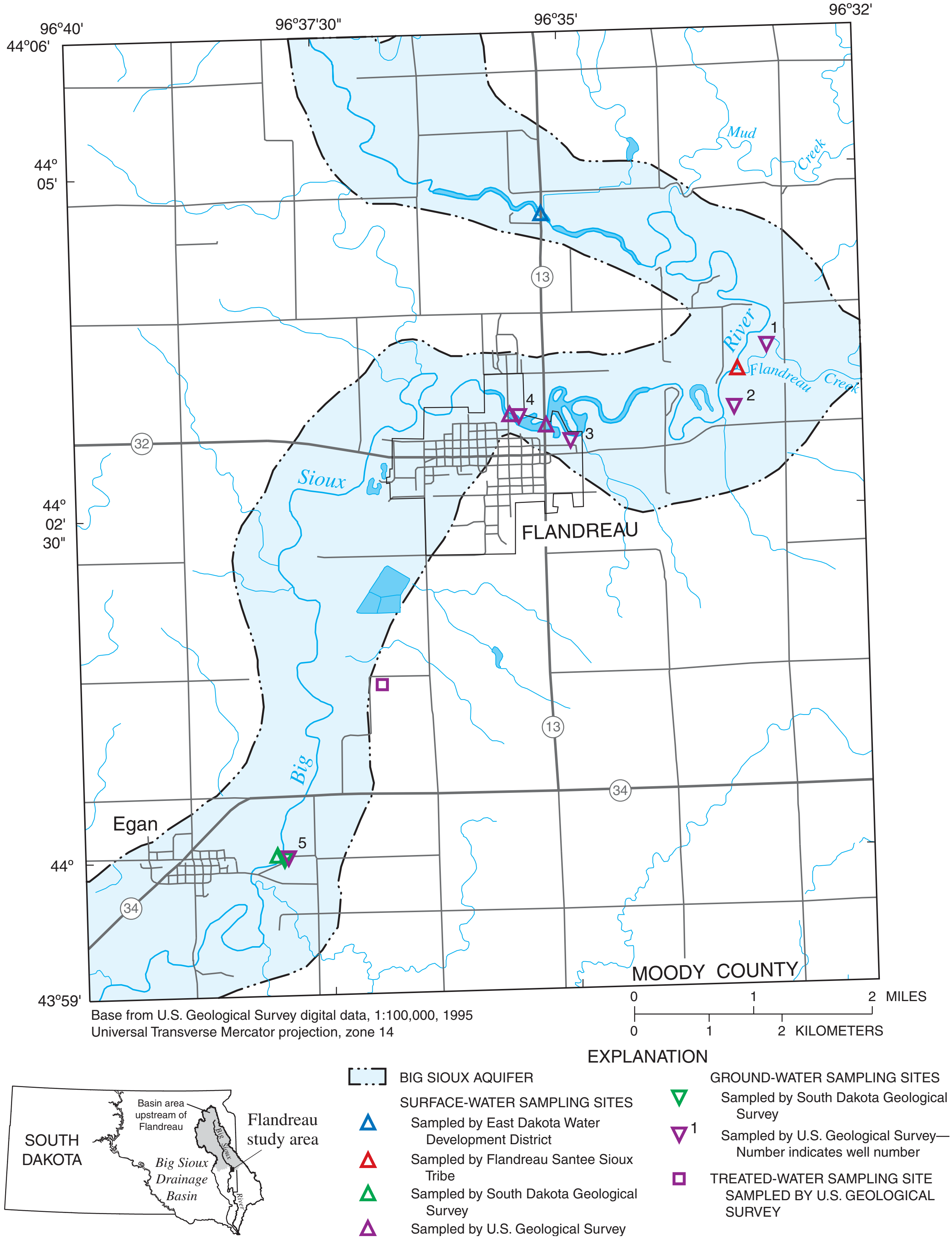

Figure 1. Location of Flandreau water-quality study area.

Purpose and Scope

The purpose of this report is to describe water-quality data relevant to the water supplies of the Flandreau Santee Sioux Tribe. Analytical results are reported for samples collected during July and August 2001 from selected surface-water, ground-water, and treated-water sites. Selected data from various other investigations also are described.

A total of 15 environmental samples, which included two sets of replicates, were collected from seven sites. Two sets of field equipment blanks, one each in July and August, also were collected. A pesticide spike sample was prepared and submitted during the August sampling period. Sample analyses included physical properties, major ions, nutrients, trace elements, and pesticides. Samples also were analyzed for many compounds that have been described as emerging contaminants including synthetic organic compounds, which may be associated with endocrine disruption, such as veterinary and human antibiotic compounds, and selected industrial and household wastewater products (Kolpin and others, 2002). Samples collected on August 27, 2001, also were analyzed for human pharmaceutical compounds. Nitrate analytical results are compared with nitrate data from other studies.

Geohydrologic Setting

The bedrock directly underlying the glacial drift in the study area consists of the Cretaceous-age Carlile Shale, Niobrara Formation, and Pierre Shale. These units, which generally do not yield water to wells, are considered to be confining beds that inhibit the movement of ground water. The surficial deposits in the Flandreau area are the result of glaciation and consist primarily of till and outwash. The Big Sioux aquifer consists of glacial outwash deposited by meltwater streams. It is an unconfined aquifer that is hydraulically connected to the Big Sioux River and has a maximum aquifer thickness of about 50 ft in the Flandreau area (Hansen, 1986a). Locally, water movement is from the aquifer towards the Big Sioux River and generally parallel to the downstream movement of water in the Big Sioux River (Hansen, 1988). Changes of the flow direction from the aquifer to the river can occur when the river stage rises above the water table.

Acknowledgments

The author gratefully acknowledges the cooperation of all those who allowed access to the sampled sites including the owners of the domestic wells, the Flandreau Indian School, and the South Dakota Geological Survey. Support and assistance from the Flandreau Santee Sioux Tribe and the Bureau of Indian Affairs also is appreciated.

PREVIOUS INVESTIGATIONS

The Big Sioux River and the Big Sioux aquifer have been the subject of considerable interest and study over the years. The studies often have been conducted on large areas such as the upstream part of the drainage basin or counties. The water-quality components of these studies often have examined physical properties, major ions, and nutrients, but not the synthetic organic compounds known collectively as emerging contaminants.

The water resources of Lake and Moody Counties were described by Hansen (1986a). Information about the areal extent of the Big Sioux aquifer, a cross section of the Big Sioux aquifer a little north of Flandreau, and water-level data showing that locally ground-water movement in the Big Sioux aquifer is towards the Big Sioux River and generally parallel to the downstream movement of water in the Big Sioux River are presented. Seventeen samples from the Big Sioux aquifer had a mean nitrate concentration of 6.3 mg/L (milligrams per liter) with a minimum of 0.1 mg/L and a maximum of 24 mg/L.

A digital model that simulates ground-water flow in the Big Sioux aquifer for Moody County, which includes Flandreau and Egan, indicated that ground water in the Big Sioux aquifer moves locally towards the Big Sioux River and parallel to the downstream movement of water in the Big Sioux River (Hansen, 1988). The digital model, which has modest differences between simulated and measured water levels, is based on the assumptions that the Big Sioux aquifer is unconfined and the aquifer is hydraulically connected to the Big Sioux River. Hydraulic conductivity of the Big Sioux aquifer ranged from 200 to 450 ft/d in the model (Hansen, 1988).

A study by Wall and others (2001) was conducted to assess the population status of the Topeka shiner and the habitat conditions in South Dakota

streams. Topeka shiners were found in the Big Sioux River Basin, including streams in the Flandreau area. The presence of Topeka shiners, a small native fish sensitive to environmental conditions, was considered to be an indication that locally water quality generally was good and river conditions were undisturbed.

Selected water-quality data from other investigations are presented in table 1 (in the Tables section at the end of the report). Data for fecal bacteria, nitrate, arsenic, and atrazine were selected for presentation because these constituents (1) are associated with adverse health effects, (2) were analyzed for by two or more of the investigations, and (3) were detected by one or more of the investigations. Table 1 includes water-quality data for the Flandreau water-supply wells and for selected sites from other investigations. The water-quality data for the surface- and ground-water samples are presented in the order of upstream to downstream position of the sampling sites along the Big Sioux River (fig. 1). Nitrate concentrations for individual samples are presented in figure 2 and are discussed later in this report. Additional water-quality data may be obtained by contacting the organizations responsible for the investigations.

The East Dakota Water Development District collected water-quality data from the Big Sioux River and some of the tributaries in the Flandreau area during 1999 and 2000. Samples were analyzed for physical properties, turbidity, bacteria, sediment, and nutrients (Deb Ernhart, East Dakota Water Development District, written commun., 2001). At their Big Sioux River sampling site upstream of Flandreau (fig. 1), the median fecal bacteria concentration was 100 colonies per 100 mL (milliliters) and the median nitrate concentration was 0.28 mg/L (table 1).

The Flandreau Santee Sioux Tribe, Natural Resources Division, collected water-quality samples during 2000 and 2001 from the Big Sioux River upstream of Flandreau and from some of the tributaries such as Flandreau Creek and Mud Creek. The samples were analyzed for selected physical properties, bacteria, major ions, nutrients, and trace elements (Vickie Kujawa, Flandreau Santee Sioux Tribe, Department of Natural Resources, written commun., 2001). At their Big Sioux River sampling site shown in figure 1, the median fecal bacteria, nitrate, and arsenic values were 110 colonies per 100 mL, 0.37 mg/L, and 4.3 μg/L (micrograms per liter), respectively (table 1).

The city of Flandreau collected water-quality samples and submitted them for analysis to the South Dakota Department of Environment and Natural Resources, Drinking Water Program. The three municipal water-supply wells are completed in the Big Sioux aquifer near the Big Sioux River and all are less than 35 ft deep. Their locations are not shown in figure 1, but they are close to well 3, which is shown in figure 1 and was sampled for this study. Some of the samples submitted by the city were of untreated water from the water-supply wells, and some of the samples were of treated water. It is not believed that the limited treatment (chlorination and fluoridation) affected concentrations of nitrate, arsenic, or atrazine (Barbara Friedeman, South Dakota Department of Environment and Natural Resources, Drinking Water Program, oral commun., 2002). Some of the samples from the water-supply wells were from just one well and some samples were a mixture from two wells (Barbara Friedeman, South Dakota Department of Environment and Natural Resources, Drinking Water Program, written commun., 2002). The samples typically were analyzed for physical properties, major ions, nutrients, and trace elements, and occasionally for volatile organic compounds and synthetic organic compounds. From 1978-2000, the median nitrate, arsenic, and atrazine concentrations were 6.1 mg/L, 1.0 μg/L, and less than (<) 0.5 μg/L, respectively. Nitrate concentrations for the 46 samples analyzed ranged from 1.0 to 14.6 mg/L (table 1).

As part of an ongoing effort, the South Dakota Geological Survey is collecting water-quality data throughout the State from a network of wells completed in commonly used aquifers (Rich, 2001). One of the wells (R20-89-50) is completed in the Big Sioux aquifer near Egan (fig. 1) and the well field for the Big Sioux Community Water System. Samples are analyzed for a variable combination of physical properties, major ions, nutrients, trace elements, and pesticides (Rich, 2001). The median concentrations for both nitrate and atrazine of more than 40 samples collected over more than 10 years are less than the minimum reporting levels of 0.1 mg/L and 0.100 μg/L, respectively (table 1). For two samples collected in 1994 and 1999, the arsenic concentrations were <0.01 and 1.9 μg/L, respectively (Tom Rich, South Dakota Geological Survey, written commun., 2002).

Water-quality samples also were collected from the Big Sioux River (fig. 1) near well R20-89-50 by the South Dakota Geological Survey from 1990-93. These samples had a median nitrate concentration of 0.39 mg/L and a median atrazine concentration of 0.17 μg/L (table 1).

METHODS OF INVESTIGATION

The study was designed to provide a reconnaissance-level assessment of water quality in the Flandreau area. Water-quality samples were collected from the Big Sioux River and the Big Sioux aquifer in the Flandreau area and analyzed for a broad range of physical properties and chemical constituents. The quality of the water in the Big Sioux River and the Big Sioux aquifer in the Flandreau area cannot be thoroughly characterized with the limited number of samples collected within a 2-month period. The results could be used to identify possible water-quality problems that could be the focus of more comprehensive investigations in the future.

Site Selection

Selection of the sampling sites was based on access, specific concerns of the Flandreau Santee Sioux Tribe, and an overall interest in characterizing the water quality of the natural waters of the Big Sioux River and Big Sioux aquifer. By July 2001, when sampling for this study was initiated, the Big Sioux Community Water System was supplying water to the city of Flandreau, and the water-supply wells previously used by the city of Flandreau could not be sampled.

The sampling sites for this study consist of five ground-water sites, one surface-water site, and one treated-water site. All of the wells are believed to be completed in the Big Sioux aquifer, and the treated water comes from wells completed in the Big Sioux aquifer.

Well 1 (fig. 1) is a domestic well a few feet from Flandreau Creek and within about 500 ft of the Big Sioux River. Well depth is unknown, but it is believed to be shallow. Nearby test holes indicate that the Big Sioux aquifer is between 16 and 34 ft thick in this area (Hansen, 1988, fig. 3). The area around the well has been flooded in the past, including the spring of 2001 (Wesley Hansen, Flandreau Santee Sioux Tribe, Department of Natural Resources, oral commun., 2001). The water was not affected by a water softener or any other treatment between the well and the tap and was not stored in a pressure tank (Wesley Hansen, Flandreau Santee Sioux Tribe, Department of Natural Resources, oral commun., 2001). The area near the well is used primarily for hay production.

Well 2 is a domestic well about 500 ft from the Big Sioux River. The well is about 9 ft deep and about 3 ft wide and is located next to a septic tank. The area around the well consisted of the homestead with an extensive lawn.

Well 3 is about 100 ft from the Big Sioux River. Based on construction, location, and other information, this well has been tentatively identified as South Dakota Geological Survey observation well R20-92-73, which is screened from 9 to 19 ft below land surface. The well is on the northeast side of Flandreau, and the area immediately around the well is used as pasture for horses, whereas the larger area primarily is residential. This well is within a few hundred feet of some of the city of Flandreau's water-supply wells and within about a thousand feet of all of them.

Well 4 is one of the production wells for the Flandreau Indian School. The well is located near the flood plain of the Big Sioux River and within about 100 ft of the Big Sioux River. The area nearest the well is used as a park or is undeveloped. The school campus is upgradient of the well.

The surface-water samples were collected from the Big Sioux River. In July, the samples were collected from the Highway 13 bridge (06480655 Big Sioux River at Flandreau) when streamflow was measured at 831 ft^3/s. The drainage area for this site is 4,096 mi^2 (Niehus, 1996). Based on information for gaging stations upstream and downstream of this site (Burr and others, 2002), the daily mean streamflow was estimated to be 360 ft^3/s. The streamflow measurement made in conjunction with the collection of the water-quality samples indicated that water depths and velocities were quite variable at this site, which makes it more difficult to collect representative samples. The August samples were collected about one-third of a mile farther downstream from the bridge along the north-south road between the city of Flandreau and the Flandreau Indian School. This site is downstream from a small dam, which probably indicates that the water is well mixed by the time it reaches this sampling site, and the water depths and velocities were much more uniform than at the Highway 13 site. The streamflow was measured at 388 ft^3/s when the samples were collected in August.

The treated-water site is approximately midway between the well field completed in the Big Sioux aquifer near Egan and the city of Flandreau (fig. 1). Samples from this site are considered to be representative of treated water from the Big Sioux Community Water System coming into the Flandreau distribution system.

Well 5 (SDGS R20-89-50) is part of the South Dakota Geological Survey water-quality-monitoring network. It is the shallower of the two network wells (R20-89-49 is the other) at this location, and it has a depth of less than 25 ft below land surface. This well was selected for this study because it had a greater percentage of nitrate detections with higher concentrations than R20-89-49 (Tom Rich, South Dakota Geological Survey, written commun., 2001). Therefore, of the two wells, it was considered to be more affected by human activity and more likely to produce water samples that might contain the analytes of interest.

Sample Collection

In general, sampling procedures followed guidelines described by Wilde and others (1999), but these procedures were adapted to the conditions encountered at the different sites in an effort to obtain representative samples. For each set of samples, this process involved some combination of collecting water in the bottles, directly or after filtering, or collecting several liters of water in a large container and later transferring it to the appropriate bottle in the laboratory.

Water from well 1 was collected by filling a large glass container from a tap inside the house. The container was filled after the pump had been running for several minutes. For the rest of the well sites, water was directed through a flow-through chamber where several physical properties, such as pH, specific conductance, dissolved oxygen, and water temperature, were monitored. After these physical properties had stabilized, the discharge tube was disconnected from the flow-through chamber and collection of samples began. Water from wells 2 and 3 was collected using a 1¾-inch stainless steel, variable-speed submersible pump with Teflon™-lined discharge hose. For well 4, the pump already in place at this production well was used to purge the system, and samples were collected from a tap in the well house using a discharge tube. Water from well 5 was collected using the dedicated pump and the dedicated discharge tubing.

The surface-water samples from the Big Sioux River were collected using width and depth integrating procedures (Wilde and others, 1999, p. 39-47). First a streamflow measurement was made, and then subsamples were collected at selected intervals using a D77 sampler with a Teflon™ bottle. The subsamples were composited in the appropriate containers. Velocities were lower than those suggested as minimum limits for this sampling method and equipment during sample collection, but this was considered to be the technique most likely to produce samples representative of the water in the river.

The treated-water sample was collected by connecting a Teflon™-lined tube to a hydrant and proceeding with the sample collection as described for the wells. The water was directed through a flow-through chamber, and after physical properties had stabilized, the discharge tube was disconnected from the flow-through chamber and collection of samples began.

For determination of "dissolved" constituents, filtering was performed using precleaned 0.45-µm (micrometer) capsule filters for inorganic constituents or precleaned baked glass-fiber 142-mm (millimeter) filters for organic constituents. Preservatives of nitric acid, hydrochloric acid, and sulfuric acid were added as needed to the samples. All samples were chilled and then sent to the appropriate laboratory so that they arrived the day after they had been collected.

Analytical Methods

Standard methods were used to analyze samples for physical properties, major ions, nutrients, trace elements, and pesticides (table 2) at the USGS National Water Quality Laboratory in Denver, Colorado (information on specific analytical methods is available on the World Wide Web at URL http://nwql.usgs.gov/Public/ref_list.html). Developmental methods were used to analyze samples for the emerging contaminants listed as antibiotic compounds (table 3), selected human pharmaceutical compounds (table 4), and organic wastewater compounds (tables 5 and 6). These developmental methods are described in detail by Barnes and others (2002) as method 1 (Meyer and others, 2000; Kolpin and others, 2002), method 3 (Kolpin and others, 2002), and method 4 (Brown and others, 1999; Barber and others, 2000).

Reporting Levels

For some of the analytical methods being developed, method detection levels and laboratory reporting levels are still being determined, but provisional values are available. Childress and others (1999) provided a detailed discussion about the approach used by the USGS regarding detection levels and reporting levels.

The method detection level is the concentration at which the false positive risk is minimized to be no more than 1 percent of the reported values. The laboratory reporting level is the concentration at which the false negative error rate is minimized to be no more than 1 percent of the reported results. The laboratory reporting level is two times the method detection level. These levels may be described as provisional for a developmental method if the levels have been based on a limited number of analytical results. Also, these levels may vary from sample to sample for the same analyte and the same method if matrix effects or other factors arise that interfere with the analysis. Concentrations measured between the method detection level and the laboratory reporting level are described as estimated values.

The minimum reporting level is used to indicate whether or not an analyte has been detected. The concentration does not have the same sort of specific definition as the method detection level and is based on the reliability of the measurements and the specific uses of the data (Childress and others, 1999).

QUALITY ASSURANCE AND QUALITY CONTROL

Analytical results should describe the environmental waters at the time the samples were collected. Unfortunately, problems such as sampling error, contamination, degradation, and analytical error can affect the process and ultimately lead to analytical results that are not representative of the natural conditions. Several techniques, collectively known as quality assurance and quality control, were used to evaluate the precision and accuracy of the reported analytical results for this study. Quality-assurance samples collected during this study included field equipment blank samples, replicate samples, and a pesticide spike sample. Analytical results for the quality-assurance and quality-control samples are presented in table 2, along with the analytical results for the environmental samples. In addition, some constituents were analyzed by multiple methods, which allows for the comparison of the results for different methods.

Field Equipment Blank Samples

Blank samples are used to assess the possible contamination of samples or analytical error. The field equipment blank samples were collected in the field by processing laboratory-grade blank water and using the same procedures and equipment used to collect environmental samples. These samples were collected at the same location as the environmental samples and just before the environmental samples were collected. If no contamination of the sample is introduced during the collection, processing, transport, and analysis of the blank sample, and the analytical results are accurate, then none of the analytes should be detected. If the analytical results indicate that the field equipment blank has analyte concentrations greater than the laboratory-grade blank water, then it may be an indication that the sample was contaminated during the process or that the analytical technique is overestimating the analyte of interest.

One set of field equipment blanks was collected during both July and August (table 2). The July field equipment blank was collected at well 2, where the complete set of sampling equipment including the pump was supplied by the USGS. If any contamination was being introduced by any of the equipment, it should have been introduced into this set of samples. The August field equipment blank was collected at the Big Sioux River. The opportunity for contamination of this blank was high with passing traffic on the bridge and the many transitions from sampler to compositing container. The field equipment blank samples were analyzed for physical properties, major ions, nutrients, trace elements, pesticides, veterinary and human antibiotic compounds, and selected industrial and household wastewater products. The field equipment blank samples collected in August from the Big Sioux River also were analyzed for human pharmaceutical compounds.

Replicate Samples

A replicate sample is intended to be an exact copy of the environmental sample. It is collected soon after the environmental sample using the same equipment, uncleaned, and it is processed and transported with the environmental sample. Any differences

between the analytical results for the environmental sample and the replicate sample may indicate some combination of inconsistency of sample collection, the natural variability in the natural water, and the variability of the analytical method.

During the July and August sampling, two complete sets of samples were collected at one of the sites (table 2). One set is referred to as the environmental sample, and the other set is referred to as the replicate sample. The July replicate samples were collected at well 4, and the August replicate samples were collected at well 5. With this limited number of samples, comparisons are of limited value. Table 2 shows minor differences between the environmental and replicate samples for major ions, nutrients, and pesticides, but reported results are fairly consistent. Concentrations of the antibiotic and human pharmaceutical compounds in the environmental and replicate samples were less than laboratory and provisional laboratory reporting limits, respectively. Concentrations of the organic wastewater compounds in both sets of replicate samples differed from the associated environmental samples (table 6). This may indicate how ubiquitous these compounds are and how vulnerable these samples may be to contamination. The general agreement between the results for the environmental and replicate samples indicates consistency in the sampling methods and in the analytical methods.

Pesticide Spike

On August 27, 2001, an additional environmental pesticide sample was collected from the Big Sioux River at Flandreau. This sample was spiked with a known volume of pesticides to determine whether any chemical interferences were present in a specific matrix that could bias the analytical measurement of a pesticide concentration. Acceptable spike recoveries are a maximum deviation of 20 percent from a theoretical 100-percent recovery of the added constituent. Therefore, a spike recovery within the range of 80 to 120 percent indicates no substantial effects. The spike recoveries for the environmental sample were about 80 and 120 percent. Thus, these results are within the acceptable range and indicate that significant matrix interferences did not bias the pesticide concentrations in this report.

Compounds Analyzed Using More Than One Method

Some compounds were included in more than one analyte group (table 7), and concentrations of these compounds were determined by different laboratories using different methods. The results for these compounds can be compared in much the same way as replicates, but with the additional benefit of being able to assess the possible effects of differences in sampling methods, sample containers, different routes to the laboratories, and many other factors.

Pesticides and Organic Wastewater Compounds

Concentrations of five pesticides (carbaryl, chlorpyrifos, diazinon, metolachlor, and prometon) were determined both from the pesticides samples (filtered) and the organic wastewater compound (unfiltered) samples (table 7). The descriptions in this section are only for the environmental samples (including the replicates) and the field equipment blanks, but not the pesticide spike sample that was described earlier.

For all of the samples, the carbaryl, chlorpyrifos, and diazinon concentrations reported for both the pesticides and organic wastewater methods were less than the respective minimum reporting limits (tables 2 and 5). For metolachlor, the pesticides method has a minimum reporting limit of 0.013 μg/L, and the organic wastewater compounds method has a minimum reporting limit of 0.5 μg/L. For one sample, the metolachlor concentration reported for the pesticide method was greater than 0.013 μg/L, but the metolachlor concentrations reported for the organic wastewater compounds method were all less than 0.5 μg/L (tables 2 and 5).

For prometon, the pesticides method has a minimum reporting limit of 0.015 μg/L, and the organic wastewater compounds method has a minimum reporting limit of 0.50 μg/L. For the July and August samples from well 2, the prometon concentrations were 0.443 and 0.456 μg/L, respectively (table 2). For those same samples, the prometon concentrations reported for the organic wastewater compounds method were less than 0.50 μg/L (July) and 0.52 μg/L (August), respectively. For some of the other samples, prometon concentrations reported for the pesticides

method were more than 0.015 µg/L but much less than 0.50 µg/L (table 2), and concentrations reported for these samples using the organic wastewater compounds method were all less than 0.50 µg/L.

Antibiotic Compounds and Human Pharmaceutical Compounds

Concentrations of two compounds (sulfamethoxazole and trimethoprim) were determined using both the antibiotic compounds (filtered) method and the human pharmaceutical compounds (filtered) method (table 7). Only samples collected on August 27, 2001, were submitted for analysis by the human pharmaceutical compounds method. These samples included the field equipment blank and the environmental sample for the Big Sioux River at Flandreau. Concentrations for sulfamethoxazole and trimethoprim were less than the respective reporting limits for both methods (tables 3 and 4).

Human Pharmaceutical Compounds and Organic Wastewater Compounds

Concentrations of two compounds (caffeine and cotinine) were determined using both the selected human pharmaceutical compounds (filtered) and organic wastewater compounds (unfiltered) methods (table 7). Only samples collected on August 27, 2001, were submitted for analysis by the human pharmaceutical compounds method.

Concentrations of caffeine and cotinine for both methods were less than the respective reporting limits. For caffeine, the human pharmaceutical compounds method has a provisional laboratory reporting limit of 0.028 µg/L and the organic wastewater compounds method has a minimum reporting limit of 0.5 µg/L. For cotinine, the human pharmaceutical compounds method has a provisional laboratory reporting limit of 0.046 µg/L and the organic wastewater compounds method has a minimum reporting limit of 1.0 µg/L.

QUALITY OF WATER

The samples collected for this study were analyzed for a total of more than 200 physical properties and chemical constituents. Only samples collected on August 27, 2001, from the Big Sioux River also were analyzed for human pharmaceutical compounds. Many compounds were not detected in any of the samples and many others were detected only at low concentrations in a few of the samples. The quality of the water in the Big Sioux River and the Big Sioux aquifer in the Flandreau area cannot be thoroughly characterized with the limited number of samples collected within a 2-month period, but selected water-quality characteristics are discussed in the following sections.

The U.S. Environmental Protection Agency has established drinking-water standards for some compounds that may cause adverse health effects from long-term exposure. These standards are known as Maximum Contaminant Levels (MCLs) (U.S. Environmental Protection Agency, 2002). Because U.S. Environmental Protection Agency standards apply only to public-water supplies, the MCLs only apply to samples collected for this study from the treated-water site between Flandreau and Egan (fig. 1). For the compounds collectively known as the emerging contaminants, such standards are not available for comparison, and the long-term health effects of exposure to these compounds are unknown.

Physical Properties, Major Ions, Nutrients, Trace Elements, and Pesticides

Samples collected for this study were analyzed for the 89 physical properties and constituents presented in table 2. The analytical results for three constituents—nitrate, arsenic, and atrazine—are of particular interest because these constituents are associated with known health risks and additional information about concentrations at other locations and other times is available from other investigations (table 1).

Nitrate as nitrogen concentrations greater than 3 mg/L generally are associated with human influence and typically are associated with livestock wastes, nitrogen-based fertilizers, and septic systems (Madison and Brunett, 1985). Higher concentrations may be associated with seasonal events such as snowmelt, intense rains, or flooding. For this study, the nitrate concentration was assumed to be approximately equivalent to the nitrite plus nitrate as nitrogen concentration

reported by the USGS National Water Quality Laboratory. The nitrite concentrations for most of the samples were less than the minimum reporting level and were much less than the nitrite plus nitrate concentrations.

Nitrate concentrations for this study ranged from less than 0.050 mg/L at several sites to slightly more than 3 mg/L at the treated-water sampling site during both July and August (table 2). These concentrations are less than the MCL of 10 mg/L.

Figure 2 shows a graph of nitrate concentrations from this study and the more than 100 additional samples from various investigations summarized in table 1. From 1978-2001, the only samples with nitrate concentrations greater than the MCL were from the city of Flandreau's wells. None of the other samples had nitrate concentrations greater than 5.0 mg/L (fig. 2).

Arsenic was detected in samples from each of the sites, although some estimated concentrations were less than the minimum reporting level of 2.0 µg/L. The MCL for arsenic was 50 µg/L in 2001, but the revised MCL of 10 µg/L will become effective in 2006 (U.S. Environmental Protection Agency, 2001). The July and August samples from well 4 had arsenic concentrations greater than 10 µg/L (table 2).

Limited information about arsenic is available from other studies. A sample from the Big Sioux River had an arsenic concentration of 6.8 µg/L, but for eight samples collected from the Flandreau water-supply wells, the maximum arsenic concentration was 2.1 µg/L (table 1).

Atrazine was detected at each of the sampling sites although some of the estimated concentrations were less than the minimum reporting level of 0.007 µg/L. The highest concentrations were found in the samples from the Big Sioux River (table 2), but the reported concentrations were well below the MCL of 3 µg/L. Most of the atrazine data available from other investigations is from the Egan area, where 42 groundwater samples had a maximum atrazine concentration of 0.72 µg/L and 8 surface-water samples had a maximum concentration of 3.0 µg/L (table 1).

Antibiotic Compounds

Samples collected for this study were analyzed for the 26 compounds presented in table 3. The laboratory reporting limits ranged from 0.01 to 0.1 µg/L for the compounds, except for roxarsone, which had a laboratory reporting limit of 0.5 µg/L. None of the environmental or quality-assurance/quality-control samples had concentrations of antibiotic compounds greater than the respective laboratory limits.

Human Pharmaceutical Compounds

The field equipment blank and the environmental samples collected at the Big Sioux River site on August 27, 2001, were analyzed for the 33 compounds presented in table 4. The provisional laboratory reporting limits ranged from 0.007 to 0.058 µg/L for the compounds, except for enalaprilat, which had a provisional laboratory reporting limit of 0.300 µg/L. Neither of the samples had concentrations of human pharmaceutical compounds greater than the respective provisional laboratory reporting limits (table 4).

Organic Wastewater Compounds

Samples collected for this study were analyzed for the 67 compounds presented in table 5. The method reporting limits range from 0.50 to 5.0 µg/L for the compounds (table 5). Table 6 shows the compounds detected in the samples for this study. No organic wastewater compounds were reported for six of the samples representing one field equipment blank and five environmental samples for five different sites. The lack of consistency among the results may be an indication of how widespread these compounds are and how difficult it is to avoid contamination during sample collection, processing, and analysis. In one case, two compounds were detected in a field equipment blank, but these compounds were not detected in the associated environmental sample. For both replicate samples, compounds were detected that were not detected in the associated environmental samples. For some sites, the compounds detected in the July samples differed from those detected in the August samples, and it seemed unlikely that some of these compounds would be found in the environmental water at these sites.

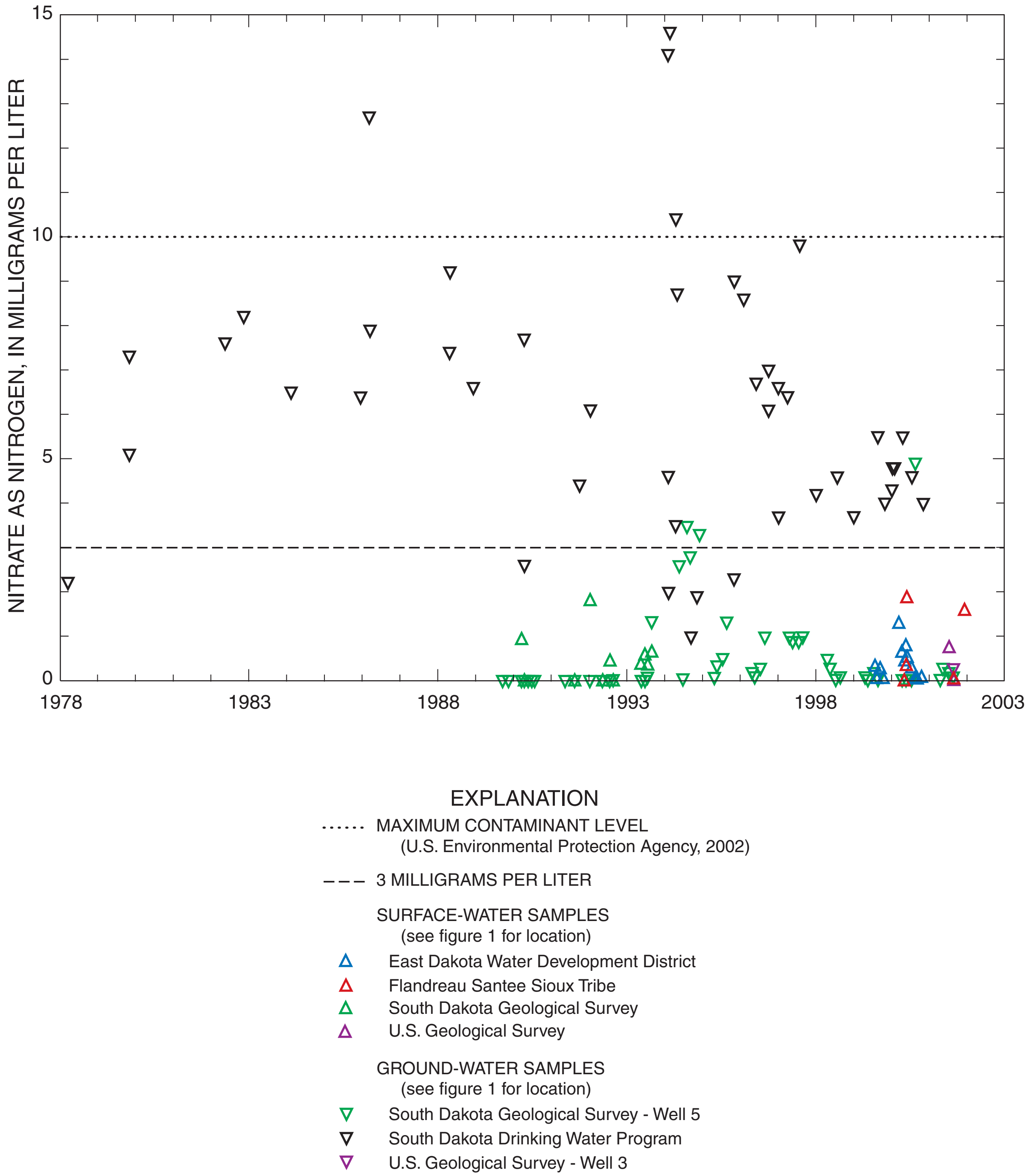

Figure 2. Nitrate concentrations in the Flandreau area.

SELECTED REFERENCES

Barber, L.B., Brown, G.K., and Zaugg, S.D., 2000, Potential endocrine disrupting organic chemicals in treated municipal wastewater and river water, *in* Keith, L.H., Jones-Lepp, T.L., and Needham, L.L., eds., Analysis of environmental endocrine disruptors: Washington D.C., American Chemical Society, ACS Symposium Series 747, p. 97-123.

Barnes, K.K., Kolpin, D.W., Meyer, M.T., Thurman, E.M., Furlong, E.T., Zaugg, S.D, and Barber, L.B., 2002, Water-quality data for pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: U.S. Geological Survey Open-File Report 02-94, accessed April 23, 2002, from URL http://toxics.usgs.gov/pubs/OFR-02-94/

Brown, G.K., Zaugg, S.D., and Barber, L.B., 1999, Wastewater analysis by gas chromatography/mass spectrometry, *in* Morganwelp, D.W., and Buxton, H.T., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the Technical Meeting, Charleston, South Carolina, March 8-12, 1999—Volume 2 of 3—Contamination of Hydrologic Systems and Related Ecosystems: U.S. Geological Survey Water-Resources Investigations Report 99-4018B, p. 431-435.

Burr, M.J., Teller, R.W., and Neitzert, K.M., 1998, Water resources data, South Dakota, water year 1997: U.S. Geological Survey Water-Data Report SD-97-1, 361 p.

———1999, Water resources data, South Dakota, water year 1998: U.S. Geological Survey Water-Data Report SD-98-1, 503 p.

———2002, Water resources data, South Dakota, water year 2001: U.S. Geological Survey Water-Data Report SD-01-1, 476 p.

Buxton, H.T., and Kolpin, D.W., 2002, Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams: U.S. Geological Survey Fact Sheet FS-027-02, 2 p.

Childress, C.J., Oblinger, Foreman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99-193, 19 p.

Hammond, P.D., 1994, Water-quality monitoring and evaluation of nonpoint-source contamination in the Big Sioux aquifer, South Dakota, 1989 through 1992: South Dakota Geological Survey Open-File Report 67-UR, 58 p.

Hansen, D.S., 1986a, Water resources of Lake and Moody Counties, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 84-4209, 51 p.

———1986b, Major aquifers in Lake and Moody Counties, South Dakota: South Dakota Geological Survey Information Pamphlet No. 31, 12 p.

———1988, Appraisal of the water resources of the Big Sioux aquifer, Moody County, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 87-4057, 38 p.

———1990, Water Resources of Codington and Grant Counties, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 89-4147, 47 p.

Horowitz, A.J., Demas, C.R., Fitzgerald, K.K., Miller, T.L., and Rickert, D.A., 1994, U.S. Geological Survey protocol for the collection and processing of surface-water samples for the subsequent determination of inorganic constituents in filtered water: U.S. Geological Survey Open-File Report 94-359, 57 p.

Kolpin, D.W., Burkhart, M.R., and Thurman, E.M., 1993, Hydrogeologic, water-quality, and land-use data for the reconnaissance of herbicides and nitrate in near-surface aquifers of the midcontinental United States, 1991: U.S. Geological Survey Open-File Report 93-114, 61 p.

Kolpin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., and Buxton, H.T., 2002, Pharmaceuticals, hormones, and other wastewater organic contaminants in U.S. streams, 1999-2000—A national reconnaissance: Environmental Science & Technology, v. 36, no. 6, p. 1202-1211.

Lindsey, M.E., Meyer, M.T., and Thurman, E.M., 2001, Analysis of trace levels of sulfonamide and tetracycline antimicrobials in groundwater and surface water using solid-phase extraction and liquid chromatography/mass spectrometry: Analytical Chemistry, v. 73, p. 4640-4646.

Madison, R.J., and Brunett, J.O., 1985, Overview of the occurrence of nitrate in ground water of the United States, *in* National Water Summary 1984—Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, p. 93-105.

Meyer, M.T., Bumgarner, J.E., Varns, J.L., Daughtridge, J.V., Thurman, E.M., and Hostetler, K.A., 2000, Use of radioimmunassay as a screen for antibiotics in confined animal feeding operations and confirmation by liquid chromatography/mass spectrometry: The Science of the Total Environment, v. 248, p. 181-187.

Niehus, C.A., 1996, Scour assessments and sediment-transport simulation for selected bridge sites in South Dakota: U.S. Geological Survey Water-Resources Investigations Report 96-4075, 80 p.

Rich, Tom, 2001, Results of monitoring from 1989 through 1997 for the statewide ground water quality monitoring network: South Dakota Geological Survey Open-File Report 89-UR, 37 p.

Scribner, E.A., Thurman, E.M., Goolsby, D.A., Meyer, M.T., Mills, M.S., and Pomes, M.L., 1993, Reconnaissance data for selected herbicides, two atrazine metabolites, and nitrate in surface water of the midwestern United States, 1989-90: U.S. Geological Survey Open-File Report 93-457, 77 p.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-455, 83 p.

Smith, S.B., and Muir, T.A., 1998, Investigations of endocrine disruption in aquatic systems associated with the National Water Quality Assessment (NAWQA) program: U.S. Geological Survey Fact Sheet FS-081-98, 4 p. (also accessible on the World Wide Web at URL http://water.usgs.gov/pubs/FS/FS-081-98/).

U.S. Environmental Protection Agency, 2001, Arsenic and clarifications to compliance and new source monitoring rule—A quick reference guide: accessed May 30, 2002, from URL http://www.epa.gov/safewater/ars/quickguide.pdf

———2002, Current drinking water standards: accessed May 30, 2002, from URL http://www.epa.gov/safewater/mcl.html

Wall, S.S., Blausey, C.M., Jenks, J.A., and Berry Jr., C.R., 2001, Topeka shiner (*Notropis topeka*) population status and habitat conditions in South Dakota streams: South Dakota State University, Brookings, South Dakota, Final report for research work order #73, various paginations and compact disc.

Welch, A.H., Watkins, S.A, Helsel, D.R., and Focazio, M.J., 2000, Arsenic in ground-water resources of the United States: U.S. Geological Survey Fact Sheet FS-063-00, 4 p. (also accessible on the World Wide Web at URL http://co.water.usgs.gov/trace/pubs/fs-063-00/).

Wilde, F.D., Britton, L.J., Miller, C.V., and Kolpin, D.W., comps., 2000, Effects of animal feeding operations on water resources and the environment—Proceedings of the technical meeting, Fort Collins, Colorado, August 30 - September 1, 1999: U.S. Geological Survey Open-File Report 00-204, 107 p.

Wilde, F.D., Radtke, D.B, Gibs, Jacob, and Iwatsubo, R.T., 1999, National field manual for the collection of water-quality data, collection of water samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4 [variously paged].

TABLES

Table 1. Selected water-quality data from various investigations

[mL, milliliter; mg/L, milligrams per liter; µg/L, micrograms per liter; NA, not available; <, less than]

Parameter	Time period	Number of samples	Median	Minimum	Maximum
Big Sioux River near Flandreau[1] (East Dakota Water Development District)					
Fecal bacteria (colonies per 100 mL)	1999-2000	13	100	1	15,000
Nitrate (mg/L)	1999-2000	13	0.28	0.036	1.30
Arsenic (µg/L)	1999-2000	0	NA	NA	NA
Atrazine (µg/L)	1999-2000	0	NA	NA	NA
Big Sioux River #4[1] (Flandreau Santee Sioux Tribe)					
Fecal bacteria (colonies per 100 mL)	2000-2001	5	110	4	500
Nitrate (mg/L)	2000-2001	5	0.37	<0.005	1.89
Arsenic (µg/L)	2000-2001	2	4.3	1.7	6.8
Atrazine (µg/L)	2000-2001	0	NA	NA	NA
Flandreau Water-Supply Wells (South Dakota Department of Environment and Natural Resources Drinking Water Program)					
Fecal bacteria (colonies per 100 mL)	1978-2000	0	NA	NA	NA
Nitrate (mg/L)	1978-2000	46	6.1	1.0	14.6
Arsenic (µg/L)	1978-2000	8	1.0	<1.0	2.1
Atrazine (µg/L)	1993-1999	3	<0.5	<0.5	<0.5
R20-89-50[1] (South Dakota Geological Survey)					
Fecal bacteria (colonies per 100 mL)	1992-2001	0	NA	NA	NA
Nitrate (mg/L)	1989-2001	50	<0.1	<0.1	4.9
Arsenic (µg/L)	1994-1999	2	0.95	<0.01	1.9
Atrazine (µg/L)	1991-2001	42	<0.100	<0.100	0.72
Big Sioux River near R20-89-50[1] (South Dakota Geological Survey)					
Fecal bacteria (colonies per 100 mL)	1990-1993	0	NA	NA	NA
Nitrate (mg/L)	1990-1993	11	0.39	<0.04	1.83
Arsenic (µg/L)	1990-1993	0	NA	NA	NA
Atrazine (µg/L)	1992-1993	8	0.17	<0.1	3.0

[1]Location shown in figure 1.

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Station number	Sample type	Date	Time (00090)	Oxidation reduction potential (mV) (00090)	Oxygen, dissolved (mg/L) (00300)	Oxygen, dissolved (percent saturation) (00301)	pH water whole field (standard units) (00400)	pH water whole lab (standard units) (00403)	Specific conductance lab (µS/cm) (90095)
Well 1	440341096325701	Env	07-10-01	1215	--	--	--	7.0	7.5	780
		Env	08-23-01	1020	-98	--	--	7.6	7.6	772
Well 2	440314096331801	FEB	07-11-01	0900	--	--	--	--	7.6	3
		Env	07-11-01	0945	222	0.1	1	7.7	7.5	1,760
		Env	08-22-01	1000	.0	2.7	23	6.0	7.4	1,480
Well 3	440301096345801	Env	08-22-01	1500	-17	.2	2	7.2	7.3	1,080
Surface-water site	06480655	Env	07-12-01	1300	--	6.3	81	8.0	8.1	1,050
		FEB	08-27-01	1020	--	--	--	--	7.6	3
		Env	08-27-01	1030	--	8.2	--	7.8	8.6	1,120
		PS	08-27-01	1033	--	--	--	--	--	--
Well 4	440312096352901	Env	07-11-01	1610	180	.3	2	7.3	7.5	1,100
		Rep	07-11-01	1615	--	--	--	--	7.4	1,100
		Env	08-21-01	1430	-184	.2	1	7.3	7.4	1,120
Treated-water site	440116096365701	Env	07-10-01	0930	6	13.8	110	8.8	8.4	477
		Env	08-21-01	0940	540	8.8	76	8.5	7.9	479
Well 5	440001096375802	Env	07-09-01	1310	598	3.2	21	7.5	7.5	740
		Env	08-20-01	1615	109	1.1	8	7.3	7.6	735
		Rep	08-20-01	1620	--	--	--	--	7.6	737

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	Specific conduct-ance (µS/cm) (00095)	Temper-ature water (deg C) (00010)	Hardness total (mg/L as $CaCO_3$) (00900)	Calcium, dissolved (mg/L as Ca) (00915)	Magne-sium, dissolved (mg/L) as Mg) (00925)	Potas-sium, dis-solved (mg/L as K) (00935)	Sodium, adsorp-tion ratio (00931)	Sodium, dissolved (mg/L as Na) (00930)	Sodium percent (00932)	ANC unfiltered TIT 4.5 lab (mg/L as $CaCO_3$) (90410)	Alka-linity, dissolved total FET field (mg/L as $CaCO_3$) (00418)	Alka-linity, dissolved total IT field (mg/L as $CaCO_3$) (39086)
Well 1	07-10-01	826	17.1	370	83.5	38.7	4.01	0.4	17.2	9	266	253	252
	08-23-01	791	20.1	370	83.4	39.2	3.97	.4	17.5	9	271	247	246
Well 2	07-11-01	--	--	0	.21	.046	.12	--	E.1	--	2	--	--
	07-11-01	1,810	12.8	330	75.2	35.2	4.77	5	216	58	242	228	228
	08-22-01	1,520	14.9	370	87.9	36.8	3.98	4	160	48	290	261	268
Well 3	08-22-01	1,110	13.6	520	134	45.1	3.81	.7	35.8	13	365	343	344
Surface-water site	07-12-01	1,070	25.1	500	90.9	66.2	9.27	.8	38.7	14	198	184	186
	08-27-01	--	--	--	E.01	<.008	<.09	--	<.1	--	2	--	--
	08-27-01	1,120	24.3	520	90.0	70.6	11.3	.8	42.8	15	193	178	176
	08-27-01	--	--	--	--	--	--	--	--	--	--	--	--
Well 4	07-11-01	1,150	10.5	520	118	55.6	7.16	.7	34.5	12	410	401	402
	07-11-01	--	--	520	118	55.8	7.10	.7	35.3	13	409	401	402
	08-21-01	1,200	11.0	540	118	58.9	8.03	.6	34.4	12	488	460	464
Treated-water site	07-10-01	437	13.3	200	32.2	29.5	3.06	.5	15.0	14	37	29	28
	08-21-01	504	15.7	200	30.3	29.2	3.17	.5	14.9	14	38	38	38
Well 5	07-09-01	654	654	270	53.3	32.6	4.27	1	49.1	28	209	199	198
	08-20-01	775	9.8	270	54.4	33.0	4.42	1	45.6	26	208	228	230
	08-20-01	--	--	280	56.4	34.3	4.47	1	46.7	26	208	--	--

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	Bicar-bonate, dissolved IT field (mg/L as HCO_3) (00453)	Car-bonate, dissolved IT field (mg/L as CO_3) (00452)	Chloride, dissolved (mg/L as Cl) (00940)	Fluoride, dissolved (mg/L as F) (00950)	Silica, dissolved (mg/L as SiO_2) (00955)	Sulfate, dissolved (mg/L as SO_4) (00945)	Solids, residue at 180 deg C, dissolved (mg/L) (70300)	Solids, sum of consti-tuents, dissolved (mg/L) (70301)	Nitrogen, ammonia, dissolved (mg/L as N) (00608)	Nitrogen, ammonia + organic total (mg/L as N) (00625)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N) (00631)	Nitrogen, nitrite, dissolved (mg/L as N) (00613)
Well 1	07-10-01	308	0.0	14.1	0.3	19.5	136	514	466	0.241	0.87	<0.050	0.012
	08-23-01	300	.0	12.5	.3	21.2	138	510	466	.281	.56	<.050	<.006
Well 2	07-11-01	--	--	.1	<.2	E.3	.1	16	--	E.024	<.08	<.050	<.006
	07-11-01	278	.0	342	.4	7.5	110	992	934	.796	1.3	<.050	E.003
	08-22-01	327	.0	236	.4	11.1	113	435	816	.618	1.2	.135	.007
Well 3	08-22-01	420	.0	31.7	.3	35.9	195	354	697	1.68	2.6	.277	E.004
Surface-water site	07-12-01	227	.0	13.4	.2	14.9	363	800	712	.080	1.1	.759	.037
	08-27-01	--	--	<.1	<.2	<.5	<.1	10	--	<.040	<.08	<.050	<.006
	08-27-01	215	.0	14.0	.2	18.1	425	858	778	<.040	1.5	<.050	<.006
	08-27-01	--	--	--	--	--	--	--	--	--	--	--	--
Well 4	07-11-01	491	.0	27.0	.3	35.2	150	736	682	3.00	3.5	.067	<.006
	07-11-01	491	.0	28.5	.3	36.4	154	718	691	3.05	3.6	<.050	<.006
	08-21-01	566	.0	31.0	.2	31.9	108	746	683	3.02	4.0	<.050	<.006
Treated-water site	07-10-01	29	2	14.1	1.1	21.0	152	332	298	<.040	E.08	3.26	<.006
	08-21-01	46	.0	13.6	1.3	21.3	157	320	307	<.040	.12	3.23	<.006
Well 5	07-09-01	242	.0	40.0	.5	11.3	113	462	425	.131	.38	.113	.012
	08-20-01	281	.0	33.6	.4	15.9	124	446	451	.127	.34	.080	<.006
	08-20-01	--	--	34.4	.4	16.0	126	454	444	.136	.37	.084	<.006

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	Phos-phorus ortho, dissolved (mg/L as P) (00671)	Phos-phorus, total (mg/L as P) (00665)	Arsenic, dissolved (µg/L as As) (01000)	Cadmium, dissolved (µg/L as Cd) (01025)	Chro-mium, dissolved (µg/L as Cr) (01030)	Copper, dissolved (µg/L as Cu) (01040)	Iron, dissolved (µg/L as Fe) (01046)	Lead, dissolved (µg/L as Pb) (01049)	Manga-nese, dissolved (µg/L as Mn) (01056)	Mercury, dissolved (µg/L as Hg) (71890)	Selenium, dissolved (µg/L as Se) (01145)	Zinc, dissolved (µg/L as Zn) (01090)
Well 1	07-10-01	<0.020	0.075	E1.4	<0.10	<0.8	E1.2	140	<1.00	1,150	0.03	<2.0	115
	08-23-01	<.020	.085	E1.8	<.10	<.8	E.6	780	<1.00	1,030	<.01	<2.0	35
Well 2	07-11-01	<.020	<.060	<2.0	.22	.9	E.9	<10	<1.00	10.1	<.01	<2.0	54
	07-11-01	<.020	E.039	E1.7	<.10	<.8	<1.0	5,230	<1.00	312	<.01	E1.8	<20
	08-22-01	<.020	.149	<2.0	<.10	<.8	<1.0	3,980	<1.00	252	<.01	<2.0	<20
Well 3	08-22-01	.820	.990	4.9	.15	<.8	2.2	120	<1.00	2,570	.03	<2.0	<20
Surface-water site	07-12-01	.142	.296	4.5	<.10	<.8	1.4	<10	E.67	22.9	<.01	<2.0	<20
	08-27-01	<.020	<.060	<2.0	<.10	<.8	<1.0	<10	<1.00	<3.0	<.01	<2.0	<20
	08-27-01	E.092	.255	6.4	<.10	<.8	E1.0	<10	<1.00	62.4	<.01	<2.0	<20
	08-27-01	--	--	--	--	--	--	--	--	--	--	--	--
Well 4	07-11-01	E.013	1.03	11.6	<.10	<.8	E.6	7,260	<1.00	2,440	<.01	<2.0	<20
	07-11-01	.155	1.00	12.0	<.10	<.8	<1.0	7,230	<1.00	2,460	<.01	<2.0	<20
	08-21-01	.434	1.03	14.0	<.10	<.8	<1.0	7,410	<1.00	2,250	<.01	<2.0	<20
Treated-water site	07-10-01	<.020	<.060	<2.0	<.10	E.4	E.7	M	<1.00	5.3	<.01	2.9	<20
	08-21-01	<.020	<.060	<2.0	<.10	E.5	E.9	<10	<1.00	<3.0	<.01	3.0	<20
Well 5	07-09-01	.166	.172	2.0	<.10	E0.5	2.5	<10	<1.00	103	<.01	<2.0	<20
	08-20-01	.162	.150	E1.8	E.09	<.8	2.6	<10	<1.00	59.0	<.01	<2.0	<20
	08-20-01	.160	.161	E1.8	<.10	<.8	2.6	<10	<1.00	75.4	<.01	<2.0	<20

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	2,6-Di-ethyl aniline, dissolved (µg/L) (82660)	Aceto-chlor, dissolved (µg/L) (49260)	Ala-chlor, dissolved, (µg/L) (46342)	Alpha BHC, dissolved (µg/L) (34253)	Atra-zine, dissolved, (µg/L) (39632)	Ben-fluralin, dissolved (µg/L) (82673)	Butylate, dissolved, (µg/L) (04028)	Car-baryl, dissolved (µg/L) (82680)	Carbo-furan, dissolved (µg/L) (82674)	Chlor-pyrifos, dissolved (µg/L) (38933)	Cyana-zine, dissolved, (µg/L) (04041)	DCPA, dissolved (µg/L) (82682)
Well 1	07-10-01	<0.002	<0.004	<0.002	<0.005	0.015	<0.010	<0.002	<0.041	<0.020	<0.005	<0.018	<0.003
	08-23-01	<.002	<.004	<.002	<.005	.012	<.010	<.002	<.041	<.020	<.005	<.018	<.003
Well 2	07-11-01	<.002	<.004	--	<.005	<.007	<.010	<.002	--	<.020	--	<.100	<.003
	07-11-01	<.002	<.004	<.002	<.005	.019	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	08-22-01	<.002	<.004	<.002	<.005	.019	<.010	<.002	<.041	<.020	<.005	<.018	<.003
Well 3	08-22-01	<.002	<.004	<.002	<.005	E.002	<.010	<.002	<.041	<.020	<.005	<.018	<.003
Surface-water site	07-12-01	<.002	.018	<.002	<.005	.211	<.010	<.002	<.041	<.020	<.005	E.010	<.003
	08-27-01	<.002	<.004	<.002	<.005	<.007	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	08-27-01	<.002	<.004	<.002	<.005	.238	<.010	<.002	<.041	<.020	<.005	E.016	<.003
	08-27-01	.098	.129	.122	.096	.351	.074	.099	E.099	E.127	.107	.120	.098
Well 4	07-11-01	.004	<.004	<.002	<.005	E.004	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	07-11-01	.004	<.004	<.002	<.005	E.003	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	08-21-01	<.002	<.004	<.002	<.005	<.007	<.010	<.002	<.041	<.020	<.005	<.018	<.003
Treated-water site	07-10-01	<.002	<.004	<.002	<.005	.019	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	08-21-01	<.002	<.004	<.002	<.005	.019	<.010	<.002	<.041	<.020	<.005	<.018	<.003
Well 5	07-09-01	<.002	<.004	<.002	<.005	.052	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	08-20-01	<.002	<.004	<.002	<.005	.056	<.010	<.002	<.041	<.020	<.005	<.018	<.003
	08-20-01	<.002	<.004	<.002	<.005	.054	<.010	<.002	<.041	<.020	<.005	<.018	<.003

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	Deethyl atrazine, dissolved, (µg/L) (04040)	Diazinon, dissolved (µg/L) (39572)	Dieldrin, dissolved (µg/L) (39381)	Disulfoton, dissolved (µg/L) (82677)	EPTC, dissolved (µg/L) (82668)	Ethalfluralin, dissolved (µg/L) (82663)	Ethoprop, dissolved (µg/L) (82672)	Fonofos, dissolved (µg/L) (04095)	Lindane, dissolved (µg/L) (39341)	Linuron, dissolved (µg/L) (82666)	Malathion, dissolved (µg/L) (39532)	Methyl azinphos, dissolved (µg/L) (82686)
Well 1	07-10-01	<0.006	E0.002	<0.005	<0.021	<0.002	<0.009	<0.005	<0.003	<0.004	<0.035	<0.027	<0.050
	08-23-01	E.003	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
Well 2	07-11-01	<.006	<.005	<.005	<.021	<.004	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	07-11-01	<.030	<.005	<.005	<.021	.003	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-22-01	E.016	<.005	<.005	<.021	<.010	<.009	<.005	<.003	<.004	<.035	<.027	<.050
Well 3	08-22-01	<.006	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
Surface-water site	07-12-01	E.017	<.005	<.005	<.021	.003	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-27-01	<.006	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-27-01	E.031	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-27-01	E.067	.109	.122	.091	.091	.083	.096	.109	.100	.171	.056	E.154
Well 4	07-11-01	<.006	<.005	<.005	<.021	.008	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	07-11-01	<.006	<.005	<.005	<.021	.010	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-21-01	<.006	<.005	<.005	<.021	.007	<.009	<.005	<.003	<.004	<.035	<.027	<.050
Treated-water site	07-10-01	E.009	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-21-01	E.013	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
Well 5	07-09-01	E.013	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-20-01	E.016	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050
	08-20-01	E.015	<.005	<.005	<.021	<.002	<.009	<.005	<.003	<.004	<.035	<.027	<.050

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	Methyl para-thion, dissolved (µg/L) (82667)	Meto-lachlor, dissolved (µg/L) (39415)	Metri-buzin sencor, dissolved (µg/L) (82630)	Molinate, dissolved (µg/L) (82671)	Naprop-amide, dissolved (µg/L) (82684)	P,P' DDE, dissolved (µg/L) (34653)	Para-thion, dissolved (µg/L) (39542)	Pebulate, dissolved (µg/L) (82669)	Pendi-methalin, dissolved (µg/L) (82683)	Per-methrin, dissolved (µg/L) (82687)	Phorate, dissolved (µg/L) (82664)	Pro-meton, dissolved, (µg/L) (04037)
Well 1	07-10-01	<0.006	<0.013	<0.006	<0.002	<0.007	<0.003	<0.007	<0.002	<0.010	<0.006	<0.011	<0.015
	08-23-01	<.006	<.013	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	<.015
Well 2	07-11-01	--	--	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	<.015
	07-11-01	<.006	E.002	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	.443
	08-22-01	<.006	E.002	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	.456
Well 3	08-22-01	<.006	<.013	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.002
Surface-water site	07-12-01	<.006	E.010	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.007
	08-27-01	<.006	<.013	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	<.015
	08-27-01	<.006	E.004	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.006
	08-27-01	.102	.139	.088	.098	.123	.067	.089	.102	.088	.053	.093	.118
Well 4	07-11-01	<.006	<.013	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.002
	07-11-01	<.006	<.013	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.002
	08-21-01	<.006	<.013	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	<.015
Treated-water site	07-10-01	<.006	E.004	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.003
	08-21-01	<.006	E.003	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	<.015
Well 5	07-09-01	<.006	E.006	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	E.012
	08-20-01	<.006	E.010	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	.017
	08-20-01	<.006	E.010	<.006	<.002	<.007	<.003	<.007	<.002	<.010	<.006	<.011	.017

Table 2. Analytical results for physical properties, major ions, nutrients, metals, and pesticides—Continued

[mV, millivolt; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; µg/L, micrograms per liter; Env, environmental; Rep, replicate, FEB, field equipment blank; PS, pesticide spike; lab, laboratory; FET, fixed end point titration; IT, incremental titration; E, estimated value; M, presence verified, not quantified; <, less than; --, no data]

Station name	Date	Pron-amide, dissolved (µg/L) (82676)	Propa-chlor, dissolved, (µg/L) (04024)	Pro-panil, dissolved (µg/L) (82679)	Pro-pargite, dissolved (µg/L) (82685)	Si-mazine, dissolved, (µg/L) (04035)	Tebu-thiuron, dissolved (µg/L) (82670)	Terbacil, dissolved (µg/L) (82665)	Ter-bufos, dissolved (µg/L) (82675)	Thio-bencarb, dissolved (µg/L) (82681)	Triallate, dissolved (µg/L) (82678)	Trifluralin, dissolved (µg/L) (82661)
Well 1	07-10-01	<0.004	<0.010	<0.011	<0.023	<0.011	<0.016	<0.034	<0.017	<0.005	<0.002	<0.009
	08-23-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
Well 2	07-11-01	<.004	<.010	<.011	<.023	<.011	<.016	E.069	<.017	--	<.002	<.009
	07-11-01	<.004	<.010	<.011	<.023	.023	<.016	<.034	<.017	<.005	<.002	<.009
	08-22-01	<.004	<.010	<.011	<.023	.022	<.016	<.034	<.017	<.005	<.002	<.009
Well 3	08-22-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
Surface-water site	07-12-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-27-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-27-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-27-01	.104	.119	.115	.198	.111	.112	E.109	.082	.112	.106	.076
Well 4	07-11-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	07-11-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-21-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
Treated-water site	07-10-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-21-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
Well 5	07-09-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-20-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009
	08-20-01	<.004	<.010	<.011	<.023	<.011	<.016	<.034	<.017	<.005	<.002	<.009

Table 3. Antibiotic compounds analyzed for in water samples

[Note: None of the compounds were detected in any of the samples analyzed for this study. LRL, Laboratory Reporting Limit; CAS, Chemical Abstracts Service Registry Number; μg/L, micrograms per liter]

Compound	LRL (μg/L)	CAS
Carbadox	0.05	6804-07-5
Chlortetracycline	.02	57-62-5
Ciprofloxacin	.01	85721-33-1
Demeclocycline	.02	00064-73-3
Doxycycline	.05	564-25-0
Enrofloxacin	.01	93106-60-6
Erythromycin-H_2O (metabolite)	.02	114-07-8
Lincomycin	.01	154-21-2
Methotrexate	.02	59-05-02
Minocycline	.02	13614-98-7
Norfloxacin	.01	70458-96-7
Oxytetracycline	.05	79-57-2
Roxarsone	.5	121-19-7
Roxithromycin	.01	80214-83-1
Sarafloxacin	.01	98105-99-8
Sulfachlorpyridazine	.05	80-32-0
Sulfadimethoxine	.01	122-11-2
Sulfamerazine	.02	127-79-7
Sulfamethazine	.01	57-68-1
Sulfamethiazole	.05	144-81-1
Sulfamethoxazole	.05	723-46-6
Sulfathiazole	.05	72-14-0
Tetracycline	.02	60-54-8
Trimethoprim	.01	738-70-5
Tylosin	.02	1401-69-0
Virginiamycin	.1	21411-53-0

Table 4. Human pharmaceutical compounds analyzed for in water samples

[PLRL, provisional laboratory reporting limit; CAS, Chemical Abstracts Service Registry Number; μg/L, micrograms per liter; <, less than; NA, not available]

Compound	Field equipment blank	Environmental[1]	PLRL (μg/L)	CAS
Acetaminophen	<PLRL	<PLRL	0.017	103-90-02
Amoxicillin	<PLRL	<PLRL	NA	26787-78-0
Azithromycin	<PLRL	<PLRL	NA	83905-01-5
Caffeine	<PLRL	<PLRL	.028	58-08-02
Carbamazapine	<PLRL	<PLRL	NA	298-46-4
Cephalexin	<PLRL	<PLRL	NA	15686-71-2
Cimetidine	<PLRL	<PLRL	.013	51481-61-9
Clarithromycin	<PLRL	<PLRL	NA	81103-11-9
Codeine	<PLRL	<PLRL	NA	76-57-3
Cotinine	<PLRL	<PLRL	.046	486-56-6
Dehydronifedipine	<PLRL	<PLRL	.019	67035-22-7
Digoxigenin	<PLRL	<PLRL	.015	1672-46-4
Digoxin	<PLRL	<PLRL	NA	20830-75-5
Diltiazem	<PLRL	<PLRL	.024	42399-41-7
Diphenhydramine	<PLRL	<PLRL	NA	147-24-0
Enalaprilat	<PLRL	<PLRL	.300	76420-72-9
Erythromycin	<PLRL	<PLRL	NA	114-07-8
Fluoxetine	<PLRL	<PLRL	.036	54910-89-3
Furosemide	<PLRL	<PLRL	NA	54-31-9
Gemfibrozil	<PLRL	<PLRL	.028	25812-30-0
Ibuprofen	<PLRL	<PLRL	.036	15687-27-1
Lisinopril	<PLRL	<PLRL	NA	76547-98-3
Metformin	<PLRL	<PLRL	.007	657-24-9
Miconazole	<PLRL	<PLRL	NA	75319-48-1
Paraxanthine	<PLRL	<PLRL	NA	611-59-6
Paroxetine metabolite	<PLRL	<PLRL	NA	NA
Ranitidine	<PLRL	<PLRL	.020	66357-35-5
Salbutamol	<PLRL	<PLRL	.058	18559-94-9
Sulfamethoxazole	<PLRL	<PLRL	.046	723-46-6
Thiabendazole	<PLRL	<PLRL	NA	148-79-8
Trimethoprim	<PLRL	<PLRL	.028	738-70-5
Urobilin	<PLRL	<PLRL	NA	NA
Warfarin	<PLRL	<PLRL	.012	81-81-2

[1]Field equipment blank and surface-water samples collected at Big Sioux River site on August 27, 2001.

Table 5. Organic wastewater compounds analyzed for in water samples

[SED, suspected endocrine disruptor; CAS, Chemical Abstract Service Registry Number; MRL, method reporting limit; µg/L, micrograms per liter. Compound uses accessible on the World Wide Web at URL http//wwwnwql.cr.usgs.gov/USGS/Reno/lc8033.html]

Compound name	SED	CAS	Possible compound uses or sources	MRL (µg/L)
1,4-Dichlorobenzene[1]	Yes	106-46-7	Moth repellent, fumigant, deodorant	0.50
17-beta-Estradiol[1]	Yes	50-28-2	Estrogen replacement therapy, estrogen metabolite	5.0
1-Methylnaphthalene	No	90-12-0	2-5 percent of gasoline, diesel fuel, or crude oil	.50
2,6-Dimethylnaphthalene	No	581-42-0	Present in diesel/kerosene (trace in gasoline)	.50
2-Methylnaphthalene	No	91-57-6	2-5 percent of gasoline, diesel fuel, or crude oil	.50
3-beta-Coprostanol	No	360-68-9	Carnivore fecal indicator	2.0
3-Methyl-1H-indole (skatol)	No	83-34-1	Fragrance, stench in feces and coal tar	1.0
3-*tert*-Butyl-4-hydroxyanisole (BHA)[1]	Yes	25013-16-5	Antioxidant, general preservative	5.0
4-Cumylphenol	Yes	599-64-4	Nonionic detergent metabolite	1.0
4-n-Octylphenol	Yes	1806-26-4	Nonionic detergent metabolite	1.0
4-*tert*-Octylphenol	Yes	140-66-9	Nonionic detergent metabolite	1.0
5-Methyl-1H-benzotriazole	No	136-85-6	Antioxidant in antifreeze and de-icers	2.0
Acetophenone	No	98-86-2	Fragrance in detergent and tobacco, flavor in beverages	.50
Acetyl-hexamethyl-tetrahydro-naphthalene (AHTN)	No	21145-77-7	Musk fragrance, persistent and widespread, in ground water, concern for bioaccumulation and toxicity	.50
Anthracene	No	120-12-7	Wood preservative, component of tar, diesel, or crude oil, combustion product	.50
Anthraquinone	No	84-65-1	Manufacturing dye/textiles, seed treatment, bird repellent	.50
Benzo[a]pyrene	Yes	50-32-8	Regulated PAH, used in cancer research, combustion product	.50
Benzophenone	Yes	119-61-9	Fixative for perfumes and soaps	.50
beta-Sitosterol	No	83-46-5	Plant sterol	2.0
beta-Stigmastanol	No	19466-47-8	Plant sterol	2.0
Bisphenol A	Yes	80-05-7	Manufacturing polycarbonate resins, antioxidant, flame retardant	1.0
Bromacil	No	314-40-9	Herbicide, general use pesticide, greater than 80 percent noncrop usage on grass/brush	.50
Bromoform[1]	No	75-25-2	Wastewater ozination byproduct, military/explosives	.50
Caffeine	No	58-08-2	Beverages, diuretic, very mobile/biodegradable	.50
Camphor	No	76-22-2	Flavor, odorant, ointments	.50
Carbaryl[2]	Yes	63-25-2	Insecticide, crop and garden uses, low persistence	1.0
Carbazole	No	86-74-8	Insecticide, manufacturing dyes, explosives, and lubricants	.50
Chlorpyrifos	Yes	2921-88-2	Insecticide, domestic pest and termite control (domestic use restricted as of 2001)	.50
Cholesterol	No	57-88-5	Often a fecal indicator, also a plant sterol	2.0

Table 5. Organic wastewater compounds analyzed for in water samples—Continued

[SED, suspected endocrine disruptor; CAS, Chemical Abstract Service Registry Number; MRL, method reporting limit; µg/L, micrograms per liter. Compound uses accessible on the World Wide Web at URL http//wwwnwql.cr.usgs.gov/USGS/Reno/lc8033.html]

Compound name	SED	CAS	Possible compound uses or sources	MRL (µg/L)
Cotinine	No	486-56-6	Primary nicotine metabolite	1.0
Diazinon	Yes	333-41-5	Insecticide, greater than 40 percent nonagricultural usage, ants, flies	.50
Dichlorvos[1]	Yes	62-73-7	Insecticide, pet collars, flies, also a degradate of naled or trichlofon	1.0
d-Limonene[1]	No	5989-27-5	Fungicide antimicrobial, antiviral, fragrance in aerosols	.50
Equilenin[1]	Yes	517-09-9	Hormone replacement therapy drug	5.0
Estrone[1]	No	53-16-7	Biogenic hormone	5.0
Ethynyl estradiol	Yes	57-63-6	Oral contraceptive	5.0
Fluoranthene	No	206-44-0	Component of coal tar and asphalt (only traces in gasoline or diesel fuel), combustion product	.50
Hexahydrohexamethyl cyclopentabenzopyran (HHCB)	No	1222-05-5	Musk fragrance, persistent and widespread, in ground water, concern for bioaccumulation and toxicity	.50
Indole	No	120-72-9	Pesticide inert ingredient, fragrance in coffee	.50
Isoborneol	No	124-76-5	Fragrance in perfumery, in disinfectants	.50
Isophorone	No	78-59-1	Solvent for lacquer, plastic, oil, silicon, resin	.50
Isopropylbenzene (cumene)[1]	No	98-82-8	Manufacturing phenol/acetone, fuels and paint thinner	.50
Isoquinoline	No	119-65-3	Flavors and fragrances	.50
Menthol	No	89-78-1	Cigarettes, cough drops, liniment, mouthwash	.50
Metalaxyl	No	57837-19-1	Herbicide, fungicide, general use pesticide, mildew, blight, pathogens, golf/turf	.50
Methyl salicylate	No	119-36-8	Liniment, food, beverage, ultraviolet-absorbing lotion	.50
Metolachlor	No	51218-45-2	Herbicide, general use pesticide, indicator of agricultural drainage	.50
N,N′ -diethyl-meta-toluamide (DEET)	No	134-62-3	Insecticide, urban uses, mosquito repellent	.50
Naphthalene	No	91-20-3	Fumigant, moth repellent, major component (about 10 percent) of gasoline	.50
Nonylphenol, diethoxy- (total, NPEO2)[3]	Yes	26027-38-3	Nonionic detergent metabolite	5.0
Octylphenol, diethoxy- (OPEO2)[3]	Yes	26636-32-8	Nonionic detergent metabolite	1.0
Octylphenol, monoethoxy- (OPEO1)[3]	Yes	26636-32-8	Nonionic detergent metabolite	1.0
para-Cresol	No	106-44-5	Wood preservative	1.0
para-Nonylphenol (total, NP)[3]	Yes	84852-15-3	Nonionic detergent metabolite	5.0
Pentachlorophenol[2]	Yes	87-86-5	Herbicide, fungicide, wood preservative, termite control	2.0
Phenanthrene	No	85-01-8	Manufacturing explosives, component of tar, diesel fuel, or crude oil, combustion product	.50
Phenol	No	108-95-2	Disinfectant, manufacturing several products, leachate	.50

Table 5. Organic wastewater compounds analyzed for in water samples—Continued

[SED, suspected endocrine disruptor; CAS, Chemical Abstract Service Registry Number; MRL, method reporting limit; µg/L, micrograms per liter. Compound uses accessible on the World Wide Web at URL http//wwwnwql.cr.usgs.gov/USGS/Reno/lc8033.html]

Compound name	SED	CAS	Possible compound uses or sources	MRL (µg/L)
Prometon	No	1610-18-0	Herbicide (noncrop only), applied prior to blacktop	0.50
Pyrene	No	129-00-0	Component of coal tar and asphalt (only traces in gasoline or diesel fuel), combustion product	.50
Tetrachloroethylene[1]	No	127-18-4	Solvent, degreaser, veterinary anthelmintic	.50
Tri(2-chloroethyl) phosphate	Yes	115-96-8	Plasticizer, flame retardant	.50
Tri(dichloroisopropyl) phosphate	Yes	13674-87-8	Flame retardant	.50
Tributyl phosphate	No	126-73-8	Antifoaming agent, flame retardant	.50
Triclosan	Yes	3380-34-5	Disinfectant, antimicrobial (concern for acquired microbial resistance)	1.0
Triethyl citrate (ethyl citrate)	No	77-93-0	Cosmetics, pharmaceuticals	.50
Triphenyl phosphate	No	115-86-6	Plasticizer, resin, wax, finish, roofing paper, flame retardant	.50
Tri(2-butoxyethyl) phosphate	No	78-51-3	Flame retardant	.50

[1]Concentration is always estimated because recovery is less than 60 percent or variability is greater than 25 percent relative standard deviation.
[2]Concentration is always estimated because of unstable instrument response.
[3]Concentration is always estimated because the reference standard is from a technical mixture.

Table 6. Concentrations of selected organic wastewater compounds

[Env, environmental; Rep, replicate; FEB, field equipment blank; µg/L, micrograms per liter; NA, not applicable]

Station number	Station name	Date (mm-dd-yyyy)	Time (24-hour)	Sample type	Detected compound	Concentration (µg/L)
440341096325701	Well 1	07-10-2001	1215	Env	None	NA
		08-23-2001	1020	Env	1,4-Dichlorobenzene	[1].53
440314096331801	Well 2	07-11-2001	0900	FEB	Acetophenone	1.1
					Phenol	[1].40
		07-11-2001	0945	Env	Caffeine	2.0
					Cholesterol	2.2
		08-22-2001	1000	Env	3-beta-Coprostanol	4.8
					Bisphenol A	1.3
					Caffeine	.84
					Cholesterol	2.6
					Prometon	.52
440301096345801	Well 3	08-22-2001	1500	Env	None	NA
06480655	Surface-water site	07-12-2001	1300	Env	None	NA
		08-27-2001	1020	FEB	None	NA
		08-27-2001	1030	Env	beta-Sitosterol	2.2
440312096352901	Well 4	07-11-2001	1610	Env	None	NA
		07-11-2001	1615	Rep	3-beta-Coprostanol	12
					beta-Sitosterol	5.9
					Cholesterol	7.3
					para-Cresol	1.0
					3-Methyl-1H-indole (skatol)	2.1
		08-21-2001	1430	Env	1,4-Dichlorobenzene	[1].67
					Phenol	[1]1.0
440116096365701	Treated-water site	07-10-2001	0930	Env	Bromoform	[1]23
		08-21-2001	0940	Env	Bromoform	[1]2.9
440001096375802	Well 5	07-09-2001	1310	Env	None	NA
		08-20-2001	1615	Env	Tributylphosphate	0.66
		08-20-2001	1620	Rep	1,4-Dichlorobenzene	[1].58
					Cholesterol	2.5
					Tributylphosphate	.63

[1]Estimated value.

Table 7. Compounds analyzed for using more than one method

[Complete lists of analytes for each method are found in the indicated tables)

Analytes	Pesticides (table 2)	Antibiotic compounds (table 3)	Human pharmaceutical compounds (table 4)	Organic wastewater compounds (table 5)
Pesticides (table 2)	Same	None	None	Carbaryl Chlorpyrifos Diazinon Metolachlor Prometon
Antibiotic compounds (table 3)	None	Same	Sulfamethoxazole Trimethoprim	None
Human pharmaceutical compounds (table 4)	None	Sulfamethoxazole Trimethoprim	Same	Caffeine Cotinine
Organic wastewater compounds (table 5)	Carbaryl Chlorpyrifos Diazinon Metolachlor Prometon	None	Caffeine Cotinine	Same